

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

April 24, 2006

Systems Group Chairman's Factual Report

DCA-06-MA-022

A. ACCIDENT

Operator: United Parcel Service Company
Location: Philadelphia International Airport (PHL), Philadelphia, Pennsylvania
Date: February 7, 2006
Time: Approximately 1159 local time
Airplane: Douglas (Boeing) DC-8-71F, N748UP

B. AIRWORTHINESS GROUP

Chairman: Scott Warren
National Transportation Safety Board
Washington, D.C.

Member: Ken Hoff
United Parcel Service
Louisville, KY

C. SUMMARY

On February 7, 2006, at 2359 eastern standard time, a Douglas DC-8-71F, N748UP, operated by United Parcel Service Company (UPS) as flight 1307, landed at Philadelphia International Airport (PHL), Philadelphia, Pennsylvania, after the crew reported a cargo smoke indication. The three crewmembers were able to evacuate the airplane using the L1 slide. Fire subsequently caused substantial damage to the airplane and numerous cargo containers on board. The three crewmembers received minor injuries. Night visual meteorological conditions prevailed and an instrument flight rules flight plan had been filed for the flight from Hartsfield-Jackson Atlanta International Airport (ATL), Atlanta, Georgia, to PHL. The scheduled cargo flight was conducted under 14 CFR Part 121.

The systems group convened on February 8-14, in Philadelphia, PA, to examine and document the aircraft electrical components in the upper cargo deck, the cockpit indications, and the smoke detectors remaining in the wreckage. Members of the systems group reconvened on March 14-15, in Philadelphia, PA to document the INU wire bundle routing and to remove additional lower cargo compartment smoke detector components for further examination.

D. DETAILS OF THE INVESTIGATION

1.0 Aircraft wiring

1.1 Fuselage

Wiring throughout the fuselage was examined for general condition and to identify which wires were present in the fuselage. From fuselage station 418 aft, there was only one major wire bundle noted. That bundle was located on the left side of the aircraft and was found lying on top of the container remnants. The systems group zip-tied the bundle together and hung it from the side of the fuselage during the cargo recovery operations. The bundle was completely severed at the location of the forward over wing exit window. This location was listed as a point of entry for the firefighters during their response. The general condition of the wiring is documented in table 1. A diagram of the DC-8 fuselage stations is shown in figure 1.

Table 1
Fuselage Upper Deck Wiring Condition Summary

Fuselage Station	Pallet Station	Total Number of Wires	Number of Shielded Wires	General Condition
35	Fwd Entry	1	0	Circuit breaker (C/B) row of 3 with middle C/B popped. Wire for this C/B was number HV L2442A16 ⁽¹⁾
36	Fwd Entry	Several	NA	Good, lightly sooted
191	2 middle	2 blue coax 2 silver coax 25 White	25 White	White insulation clearly visible. No melting of conduits. Vent duct not melted.
285	3 middle	2 blue coax 2 silver coax 25 White	25 White	Sooted and slightly charred with some drips evident on top of wires. Conduit charred, but not melted.
320	Aft of 3	3 Bundled sections	Not Recorded (N/R)	#1 INU harness is not in conduit between stations 500 forward to station 330. The harness is located on the right side of the air distribution duct. The harness is routed inside conduit above the duct and joins the #2 INU harness located to the left of the crown air distribution duct. Conduit is not melted and wire insulation visible.
375	4 middle	2 blue coax 2 silver coax 25 White	25 White	2 nd Smoke detector noted on left side – extremely charred Wiring is more charred than that at FS 285. Conduit not melted. Some white insulation visible.
418	Aft end of 4	Silver and blue coax wires stowed. 21 white wires continue on down the fuselage	21 White	Significant charring. Insulation still present, but only occasional bits of color in the insulation is visible.
418	Fwd part of 5	No silver, no blue coax	Wire count not possible	All wires are fused together into one solid mass – wires are separate, but encased in plastic type material. Conduit charred, deformed, but not fully melted.

Fuselage Station	Pallet Station	Total Number of Wires	Number of Shielded Wires	General Condition
463	Middle of 5	No silver, no blue coax	Wire count not possible	Conduit melted with some holes appearing
500	Fwd part of 6	3 bundles in conduit with 2 insulated wires in separate conduit	N/R	#1 INU harness in conduit inside the right sidewall is routed up and forward along the crown, right of the air distribution duct. Harness in this top location is not in conduit. Wire insulation is soot stained but not visibly damaged.
552	Middle of 6	No silver, no blue coax	Wire count not possible	Conduit completely melted. Significant wire charring. Some insulation burned off.
596	Fwd part of 7	N/R	N/R	Section of bundle where the wires were fused together ends – wires are now all separate. All insulation gone
600	Fwd Part of 7	3 bundles in conduit with 2 insulated wires in separate conduit	N/R	#2 INU harness in the right sidewall is routed over the crown air distribution duct and transitions forward along the left side of the air distribution duct. Conduit melting starts with wires melted together.
651	Middle of 7	55	31 large gauge, 13 small gauge	All insulation gone
680	Aft part of 7	8	4	4 shielded wires and 2 sets of twisted pairs coming up sidewall. The two sets of twisted pairs are capped and stowed at the level of the wire bundle.
715	1/3 aft of front edge of 8	53	25 large gauge, 28 small gauge	Bundle severed. In vicinity of fwd over wing exit. Limited ability to differentiate between shielded and unshielded wires
730	Middle of 8	N/R	N/R	Wire bundle continues
820	Middle of 9	N/R	N/R	Wires are burned, no insulation present

Fuselage Station	Pallet Station	Total Number of Wires	Number of Shielded Wires	General Condition
863	Start of 10	7	5 large shielded	Only a few wires found at this location
850	Aft part of 9	2	2	2 shielded wires coming up from sidewall aft of aft over wing exit
863-1130	10-12	36	9 small shielded, 21 large shielded	All wires burned, insulation gone, all separate wires, no fusing of wires
1265	Middle of 14	N/R	N/R	Found burned plug from smoke detector
1130-1308	End of 12 to start of 15	N/R	N/R	All wires burned, insulation gone, all separate wires, no fusing of wires
1308	Aft part of 14, fwd part of 15	N/R	N/R	Upper beacon installation with 2 wires hanging down. No insulation on wires.
1397	Aft end of 15	N/R	N/R	Bundle caught up in chunk of structure. Wire bundle severed.
1397	Fwd part of 16	N/R	N/R	Right side of fuselage – wire coming up sidewall in plastic conduit/sleeve. Single wire, number is HV-UL737A12
1440-1575	Mid 16-end of 17	N/R	N/R	Wire bundle separated on both ends. Front end of bundle has metal tube about 16 inches long with an inner tube and wire going to inner tube. Aft end of bundle melted into large chunk of unknown (container?) material.
1575	Aft end of 17	N/R	N/R	Wire bundle starts again
1575-1630	Fwd part of 18 to middle part of 18	N/R	N/R	Wires are fused again with melted plastic-type material
1640	2/3 of the way towards the aft end of 18	N/R	N/R	Conduit of wires coming up the sidewall on the left side. Aft of L4 door

Fuselage Station	Pallet Station	Total Number of Wires	Number of Shielded Wires	General Condition
1640	2/3 of the way towards the aft end of 18	N/R	N/R	Conduit of wires coming up the sidewall on the right side. Aft of R4 door
1660	Near end of 18	N/R	N/R	Bare wires stop and fused wires begin. Area of bare wires in area of L4 door
1660-1766	Aft end of 18 to back wall	N/R	N/R	Overhead insulation and wires charred, burned, encased in plastic-type material. Bundle terminates in DFDR. Wires going into DFDR are burned and charred, but not encased in plastic-type material.
1766	Aft wall	N/R	N/R	Wires terminating at the CVR are encased in conduit that is charred, but not melted

Note: (1) According to wiring diagram 33-30-03, sheet 2 of 2, this wire corresponds to the wires that provide power for lights at fuselage station 418, 507, 595, and 685.

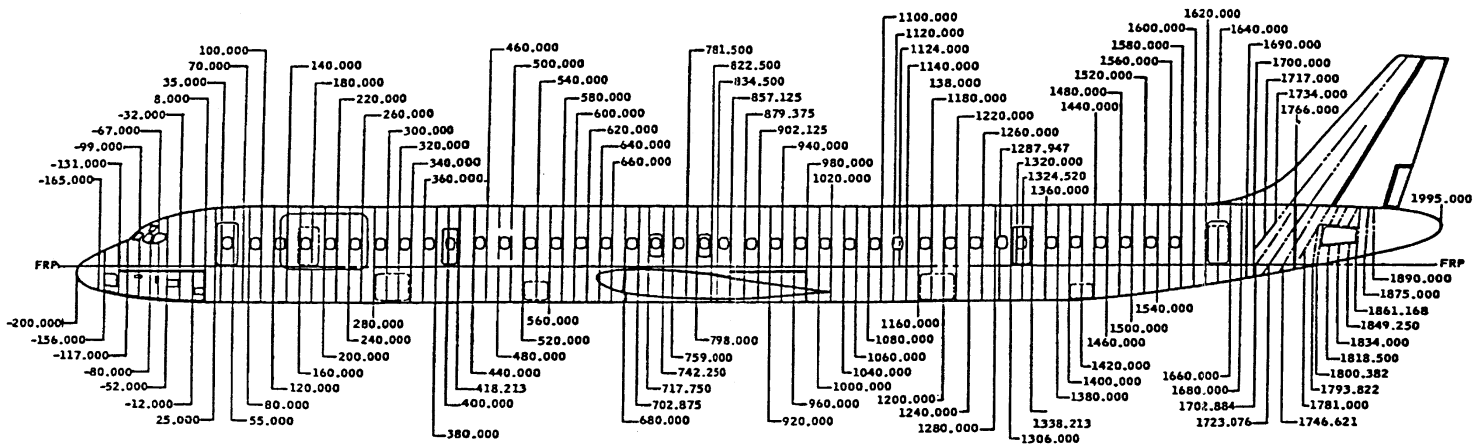


Figure 1
DC-8-71F Fuselage Station Locations

UPS provided general wire bundle locations for the FDR wiring installation. The wiring drawing (DC8341604) was dated 04/20/96, with Rev A dated 05/10/97. The company name on the drawing was Flight Systems Engineering. The drawing indicated that the wiring runs for the FDR wires are located in the upper section of the main cargo deck area.

1.2 Cockpit

The wiring in the general area of the cockpit entry way was examined and showed evidence of exposure to heat (darkening of insulation, resin drips, etc.), but the wire insulation was not charred. The wiring in the area of the avionics bays (radio racks) behind the captain's seat was examined, and it showed minor sooting on the upper sections of the wires in this bay. There did not appear to be any charring or burning of the wires. The lower sections of this bay contained wires that did not appear to have any sooting or other damage.

2.0 Cockpit Indicators

The cockpit was documented and switch positions and indicator readings were noted. The information was recorded on cockpit drawings. The main deck cargo smoke selector switch located in the cockpit was in the “NOR” position. The light switch for the main deck cargo compartment was found in the off position.

The circuit breakers in the cockpit were examined, and all of the circuit breakers were found to be “in” (closed) with the following exceptions (circuit breakers that were out and collared and labeled deactivated are not listed here):

1. Cabin Temperature Indicator – Out (open)
2. Elevator Position Indicator – Out
3. Upper Anti Collision Light - Out
4. Right Left and Center Anti-Fog – Out (Reports from UPS indicate that their pilots routinely pull this breaker during normal flight to assist in determining if the windshield anti-ice system is working properly)
5. Cargo Trough Lights (uppermost in the series of 4 with this label) – Out and Collared
6. Cargo Trough Lights (next to the lowest in the series of 4 with this label) – Out and Collared

The lower cargo compartment smoke detector system Control Display Unit (CDU) was examined in place next to the flight engineer’s panel. The CDU identifying information was:

Part Number: 100-0120-03

Serial Number: 0125

Mod 0

Software Part Number: 050-0014-98054

The CDU was removed from the aircraft for further examination.

The circuit breakers in the entryway were examined, and all of the circuit breakers were found to be “in” (closed) with the exception of the middle circuit breaker in the row of three breakers. Each row of circuit breakers in this panel was found labeled (using a label maker) as “Cabin Ceiling Lights”. (See figure 2)

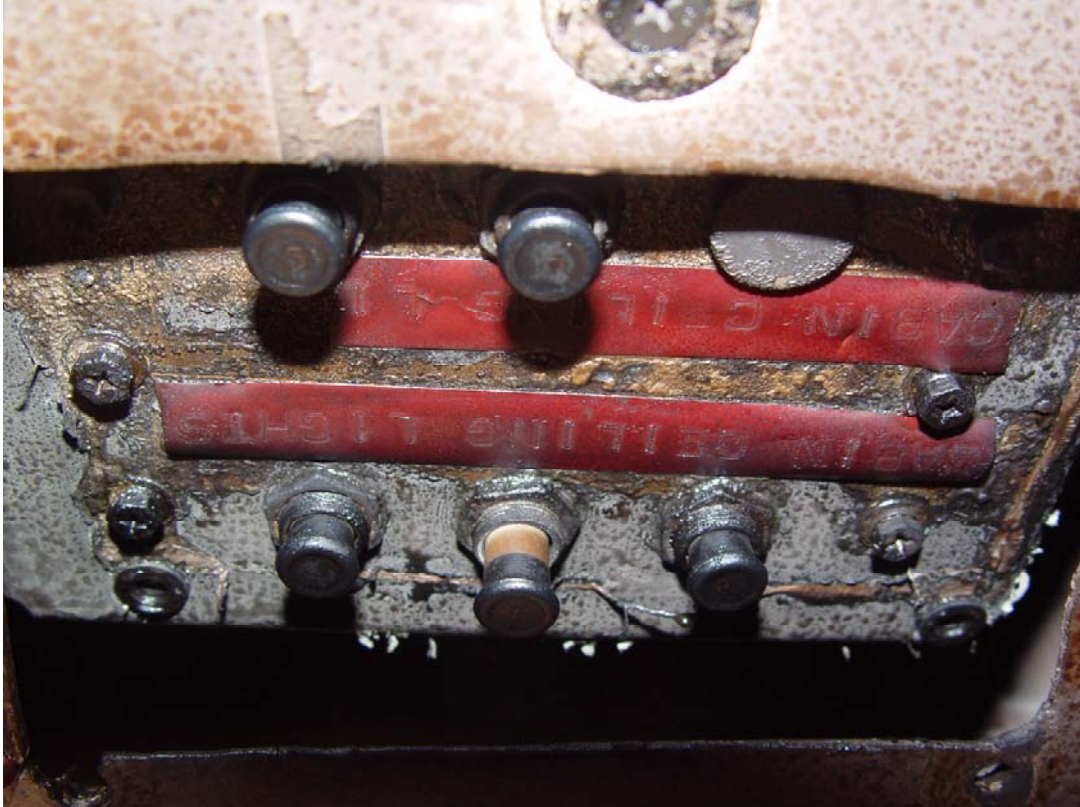


Figure 2
Circuit Breaker Panel Located in the Flight Deck Entry Area Ceiling

3.0 Main Cargo Door

3.1 Description

The forward upper cargo door is located on the left side of the fuselage in the forward section of the upper compartment. The door is approximately 85 x140 inches in size. The door is hinged at the top and opens outward and upward. The door is hydraulically operated by pressure supplied by the auxiliary hydraulic pump when the engines are not running. A hand pump is provided to supply the pressure if pressure is not available from the auxiliary hydraulic pump.

Hydraulic pressure is routed to the components of the door through a control valve located in a well in the compartment floor inboard of the entrance door. The valve has multiple positions that include: lock (normal, stowed position), operate (pulling up on the handle), open (turning the handle clockwise while in the up position), close (turning the handle counter clockwise while in the up position), and neutral (no rotation of the handle while in the up position). Placing the valve into one

of these positions allows the door to open or close using hydraulic pressure. (See figures 3 and 4)

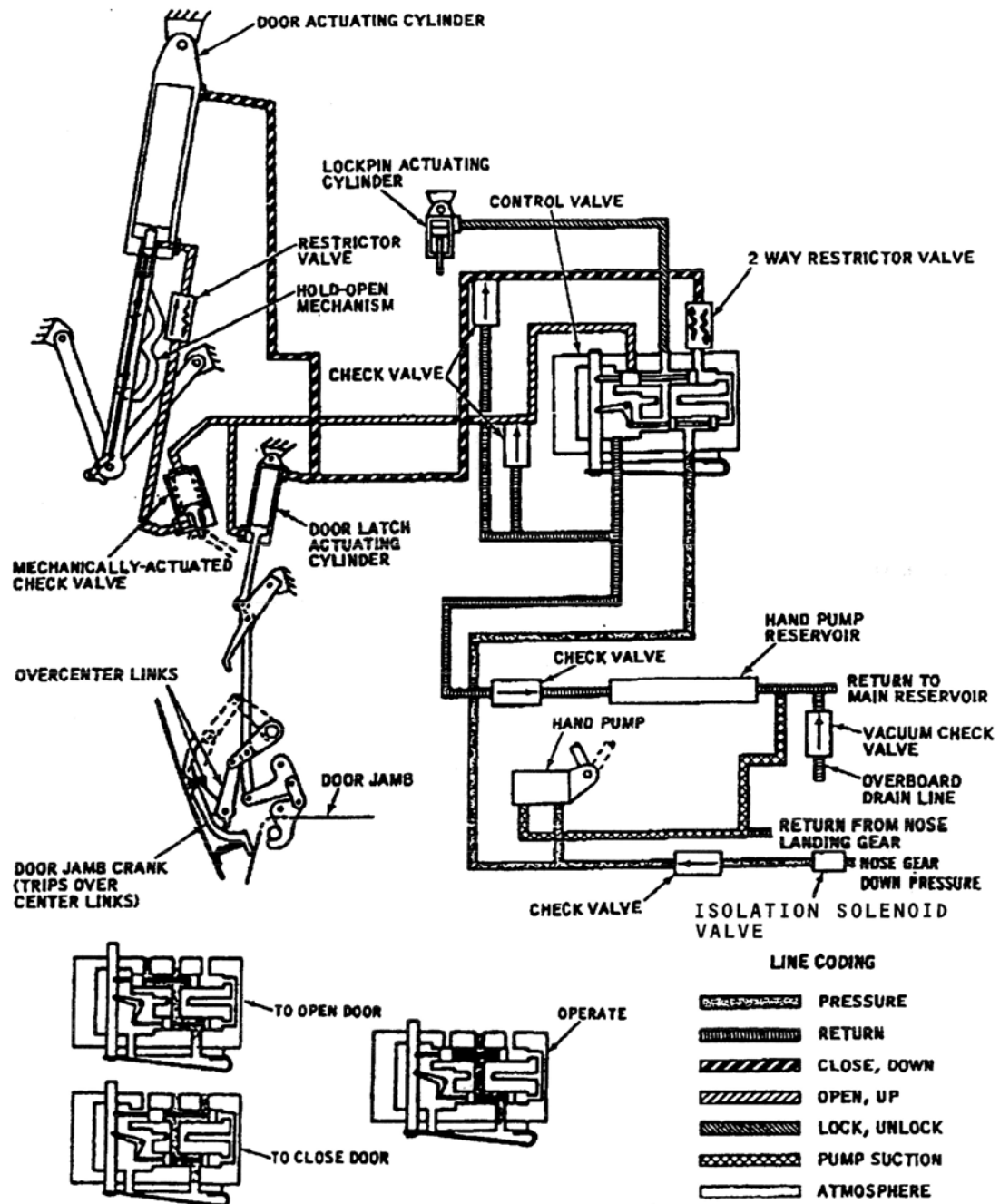


Figure 3
Cargo Door Hydraulic Schematic

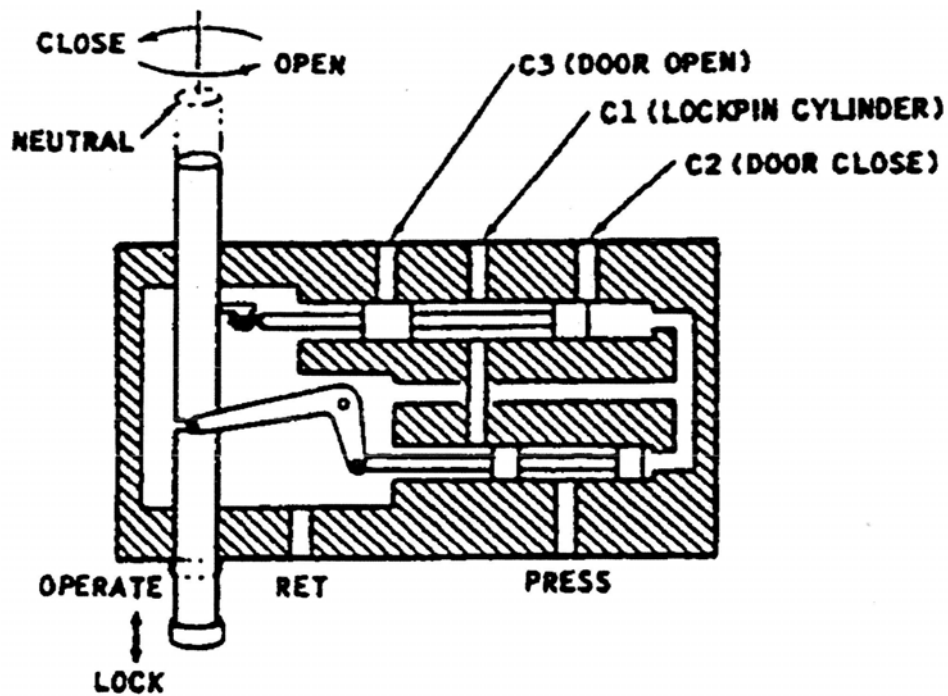


Figure 4
Cargo Door Hydraulic Control Valve Detail

The operating mechanism consists of latch assemblies installed on the lower edge of the door which engage spools installed on the doorjamb, a torque tube, a latching cylinder, a walking beam, lock pins, lockpin cylinder, a mechanically actuated check valve, a door actuating cylinder, a hand pump, interconnecting rods, links, cranks, a control valve, and an isolation valve. (See figure 5)

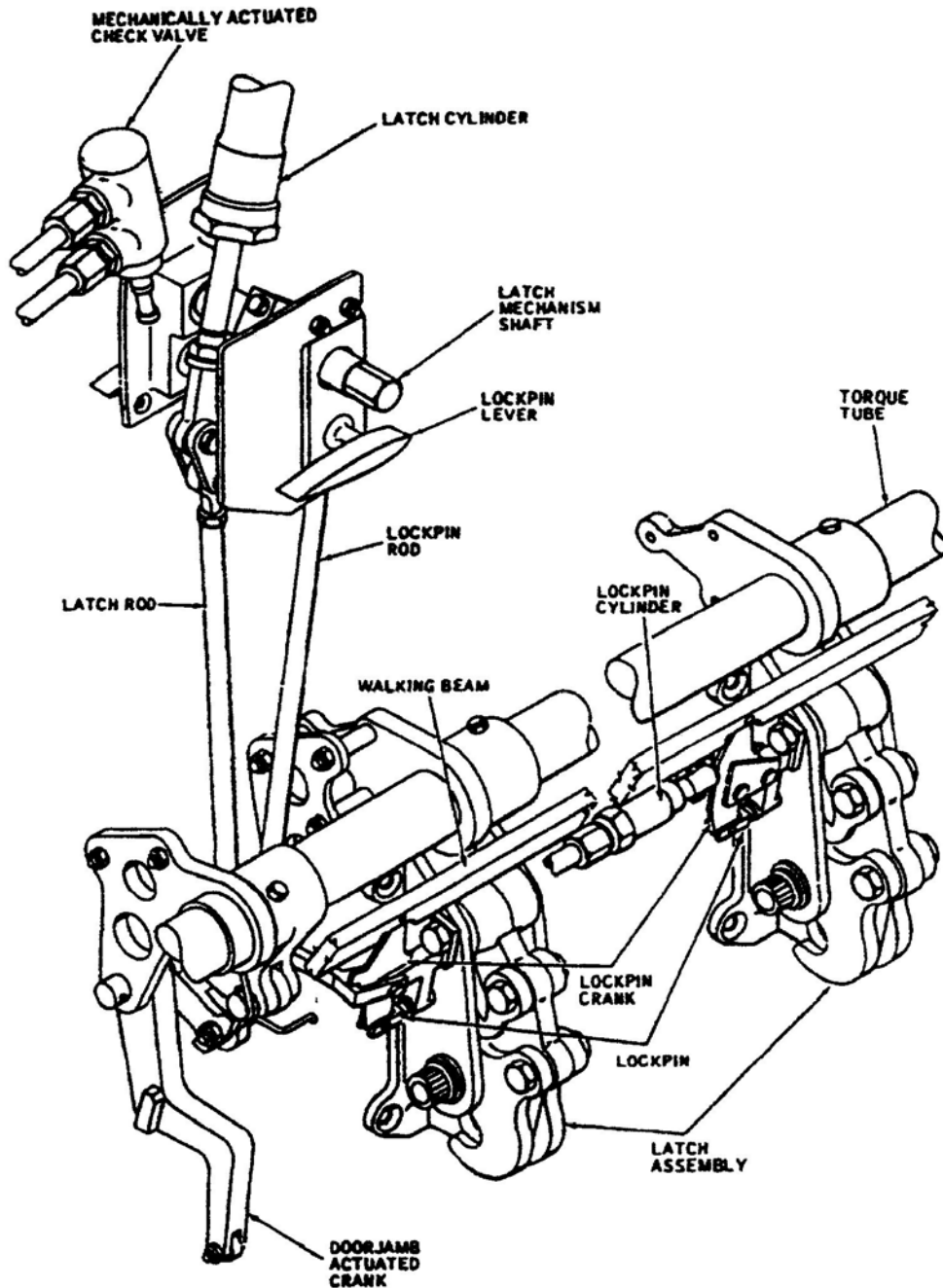


Figure 5
Cargo Door Latching Mechanisms

The latch assemblies latch the door firmly to the airplane structure when the door is closed. The latch assemblies are connected to the torque tube (which extends approximately the full length of the door just above the latches) by short rods. The torque tube is actuated, to open and close the latches, by the latch cylinder. The latches may be opened or closed

manually by attaching a handle to a shaft on the torque tube actuating mechanism (the shaft extends through the door so that the latches may be actuated manually from the inside or outside of the airplane).

The walking beam, which controls the movement of the lockpins by cranks and rods, is actuated by moving the lockpin cylinder to the unlocked position. The walking beam is spring loaded to return the beam and the lockpins to the locked position when hydraulic pressure is not applied to the lockpin cylinder. The walking beam may be actuated manually from inside or outside the airplane by a control lever attached to the walking beam actuating linkage. The lockpins lock the latch assemblies in the door-latched position when the door is closed, and in the open position when the door is open to prevent closing the latches with the door in the open position (the latches are also in an over center condition when the door is open).

The upper cargo door includes a vent door assembly. The vent door is designed so that it cannot be closed unless the cargo door is closed, latched, and locked. Similarly, the cargo door cannot be opened until the vent door is opened.

3.2 Normal Operation

Normal procedures for opening the upper cargo door require the vent door to be opened first. The vent door is operated from a switch at the crew entry door.

Once the vent door is open, the control valve is placed in the operate and open positions (pulling up, and rotating clockwise). This position applies power to the auxiliary hydraulic pump and applies hydraulic pressure to the appropriate components in the door opening sequence.

3.3 Manual Operation

According to the DC-8 maintenance manual, to open the cargo door manually, the vent door must be open, "the lock pin control lever must be actuated (and held until the latches start to open) to the unlocked position, and the latch mechanism shaft rotated to the open position (the hand pump handle may be used as a handle for the latch mechanism shaft). When the latches are open the door will swing open far enough to clear the latch assemblies from the spools on the doorjamb."

Examination of the cargo door determined that the vent door, when opened, is designed to provide movement through 2 flex lines that pull a

pin out of the walking beam that controls the lock pins. With this pin removed, moving the lock pin control lever is designed to move the walking beam that moves all of the lock pins out of the latches at the same time. With the lock pins moved, rotating the latch mechanism shaft (hex nut) to the unlocked position is designed to move linkages that rotate the latches away from the rollers. When the latches are moved away from the rollers, the door is then free to move by the use of either the auxiliary hydraulic pump (for normal operation), or by use of the hand pump.

When this procedure was followed during tests on a different DC-8 (with the same type door), the door did not swing open. The door remained in the closed position until the control valve was moved to the open position and the hand pump was operated.

During additional tests, when the hand pump was operated without moving any of the other levers or the control valve, the door did not open.

When the hand pump was operated after the control valve was moved to the open position, the results varied. During some tests when the hand pump was operated, the lock pin lever moved to the unlocked position, the latch mechanism shaft rotated to the open position, and the door started to open. During other tests when the hand pump was operated, the control valve had to be manipulated up and down several times before the other mechanisms started to move.

Examination of the cargo door on the accident airplane further determined that the linkage between the lock pin control lever and the walking beam was cut. The hydraulic lines and latch cylinder were cut. These cut areas appeared to be consistent with descriptions of areas that were cut by the airport rescue personnel. The lock pin lever was free to turn 360 degrees, and it did not move the linkage associated with it. The linkages between the torque tube and the latches were cut on all 7 latches. Three of the 7 latches were cut to the point where they were not engaged on the rollers.

4.0 Upper Cargo Deck Smoke Detectors

According to the smoke detector manufacturer, the smoke detector assembly consists of a perforated cage and a shock mounted base assembly to which is mounted a labyrinth assembly, terminal board assembly, connector and the wiring necessary to complete the installation. The labyrinth is a specially designed chamber that houses a photocell, beacon light source, and a test light source. The beacon light source is mounted at a 90 deg angle to the photocell. The test light source is mounted at a 180 deg angle from the photocell. During normal operation, power is constantly applied to the beacon light source and the photocell. An external power source separately

provides 28 volts DC to the photocell and to the beacon light source. Due to the position of the light source and the construction of the labyrinth, no direct light is reflected into the photocell. When smoke enters the labyrinth and reaches a specified density (80-90 % of normal light transmission), light from the beacon source is partially reflected into the photocell. The reflected light causes the photocell's resistance to lower, allowing a higher signal voltage to be applied to the alarm circuit. When the density of the smoke decreases to a safe condition level, the photocell voltage drops to the calibrated value, causing the detector to reset to a standby condition.

According to documentation provided by UPS, seven Pyrotec Inc. photoelectric smoke detectors were installed in the main deck cabin ceiling. Five of the detectors were mounted on the left side of the ceiling at locations corresponding to pallet positions 2, 5, 8, 11/12, and 14. Two detectors were mounted next to each other close to the ceiling centerline at positions corresponding to pallet position 17/18.

5.0 Lower Cargo Compartments

There are 4 lower lobe cargo compartments on the airplane. These compartments on DC-8 aircraft were originally designated as class D compartments that did not require fire detection or suppression systems. The compartments are currently considered to be class E compartments due to new regulations. Suppression systems are not required for class E compartments.

All of the lower deck cargo and avionics compartments were inspected and checked for signs of sooting, burning, or melted materials. None of these signs were found on the interior surfaces of the cargo compartment liners on the walls, ceilings, or floors of any of these compartments with the exception of some soot in the avionics compartment that appeared to be associated with water drainage. Securaplane Technologies wireless smoke detectors were noted in all of the lower cargo compartments.

5.1 Compartment 32

The inertial navigation units (INS #1 and INS #2) were checked, and there was evidence of sooting on the cooling fans for both units. The cooling fan for INS #1 appeared to have slightly more soot on it than the cooling fan for INS#2. Compartment 32 is below the positions for pallets 6 and 7. Both of these INS units were removed from the aircraft for further examination. The identifying information for these units was:

INS #1 LTN 92

P/N: 463001-61800413

S/N: 0629

Mfg date: May 89

INS #2 LTN 92

P/N: 463001-61800413

S/N: 0710

Mfg date: July 89

5.2 Compartment 33

The smoke detectors for this compartment were removed for further investigation. After removal of each unit, it was found that there was a small amount of air flow (with a burned smell) coming through the smoke detector receptacle into the compartment. The detectors were arbitrarily assigned a number starting with #1 at the fwd end of the compartment. The identifying information for the removed units was (the units were all manufactured by Securaplane Technologies LLC):

Detector #1

P/N: 100-0649-01

S/N: 1256

Detector #2

P/N: 100-0649-01

S/N: 3785

Detector #3

P/N: 100-0649-01

S/N: 7434

Detector #4

P/N: 100-0649-01

S/N: 2294

Detector #5

P/N: 100-0649-01

S/N: 13162

5.3 Mid Accessory Compartment

The lower cargo compartment smoke detection system Central Control Unit (CCU) is the control center for the wireless smoke detectors. The CCU is located in the lower mid accessory compartment, fuselage station 680. The CCU was removed for further examination and displayed identifying information as follows:

Securaplane CCU

PN: 100-1052-01

SN: 0291

Scott Warren
Lead Aerospace Engineer